Engineering Professional practice: Skills to advance your career

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It is widely accepted that Engineers require breadth in their education to understand and engage with the wider issues confronting society: indeed engineers should not only be solving society's problems but also contributing to the debate and asking the right questions about how we develop as a society in the future. Management education is a key part of this broader education for professional Engineers.

Recent research in NZ further has clarified the importance of engineering management (EM) for professional Engineers, and that practising Engineers use engineering management to increasing extent as their careers progress, see Figure 1.

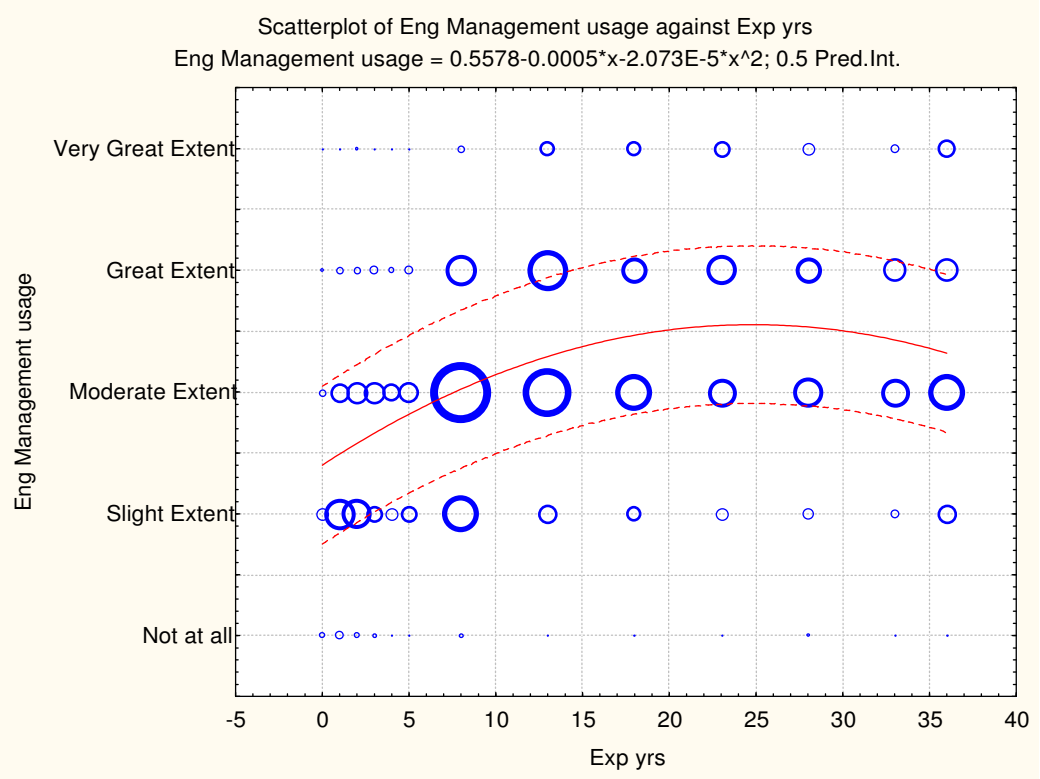

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Figure 1: Usage of engineering management increases as an Engineer gains years of experience. The size and thickness of the circles shows the number of data points in that region, and the solid curved line shows the polynomial fit. The dotted lines are the 50% predicted interval, i.e. half the Engineers were within these bounds. The biggest increase in usage of engineering management (steepest slope) occurs within the first decade of a career. Towards the end of a career the involvement in management drops somewhat, at least for the average Engineer: this might correspond to moving out of management and back into technical and part-time roles.

Both the usage of engineering management and IPENZ job points (a measure of job complexity and indirectly of remuneration) go up with years of experience, see Figure 2. Three general career paths can be identified in the results, corresponding to careers that focus on the technical path, engineering management, or complex engineering (involves solving engineering problems that are cross-linked into other issues like economics, clients, environmental, human resources). Perhaps 'OR' is not the best word, because the career for any individual Engineer could traverse a complicated path across this surface (and it is only the average surface that is shown here), as they move in and out of roles. All the same, the results broadly support the IPENZ career model with its progression into 'independent practice', 'team leader', 'technical manager', and 'general manager'. The take-home message is that engineering management is not just some optional alien thing that a few deviant Engineers do when they are not doing the 'real' quantitative science & technology based stuff, but an integral and usually essential component of most professional careers in Engineering. In fact, the results show that Engineers who use engineering management to a low extent, are very much in the minority. And probably don't get paid as much either.

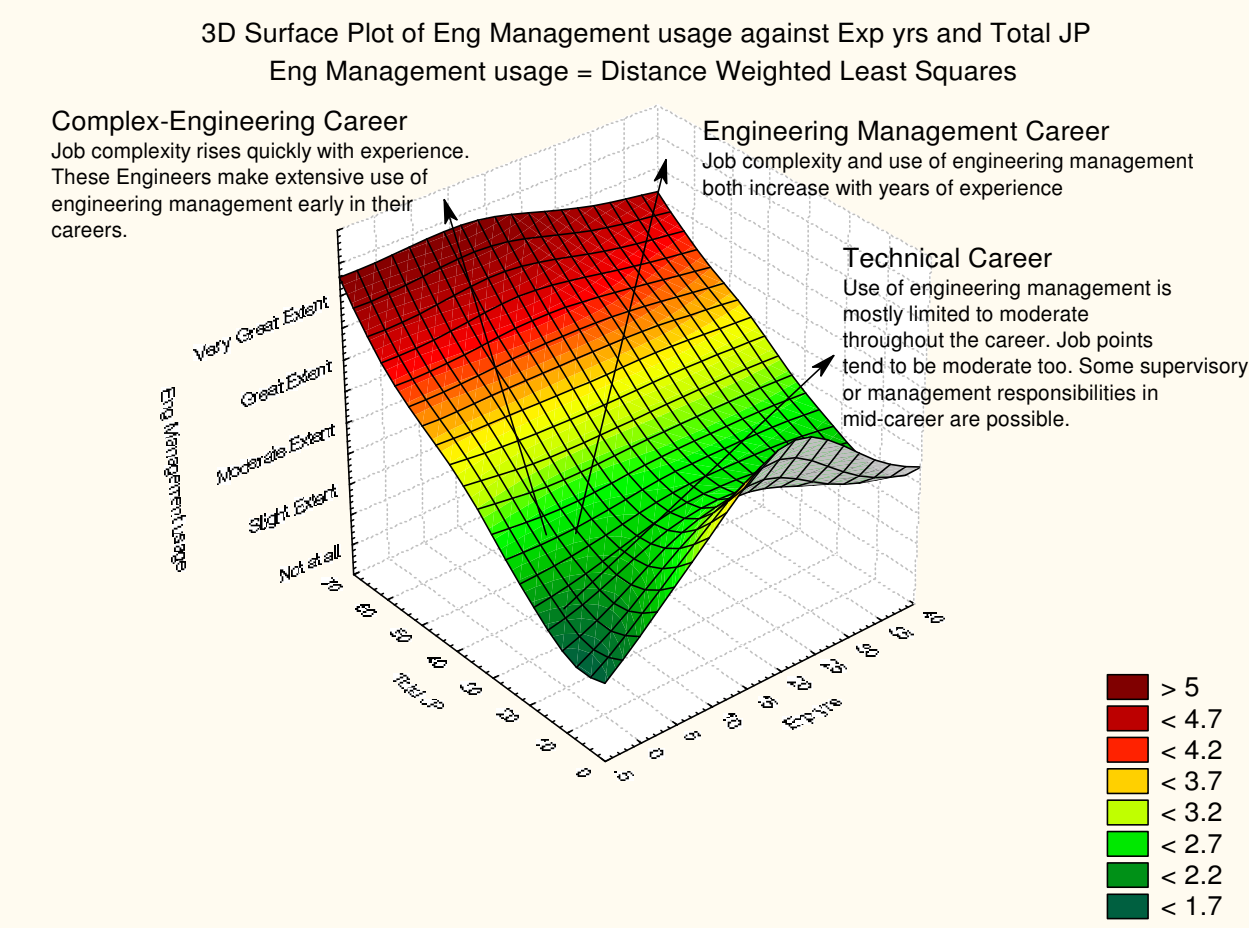

Figure 2: 3D Scatterplot of usage of engineering management against both years of experience and job points. The surface shown here is the mean based on a least-squares fit, and the shading represents the usage of engineering management. Three broad trends are shown as arrows, but these are only representative and interpretive. Note that some regions are poorly populated with data even though a mean is indicated. So please do not read these results as meaning that someone is doomed to follow only one of the three arrows!

The research, which surveyed practising professional engineers who were members of IPENZ, identified the most important EM topics as Communications and Project Planning, closely followed by Project Costing, Ethics, Team Development, and Project monitoring. The full list of topics and their relative importances is shown in Figure 3. The implications are that an educational or professional development programme that primarily interpreted 'engineering-management' as financial management and economics would be incomplete according to the findings here, although these topics assume more importance for engineers who have moved into general management.

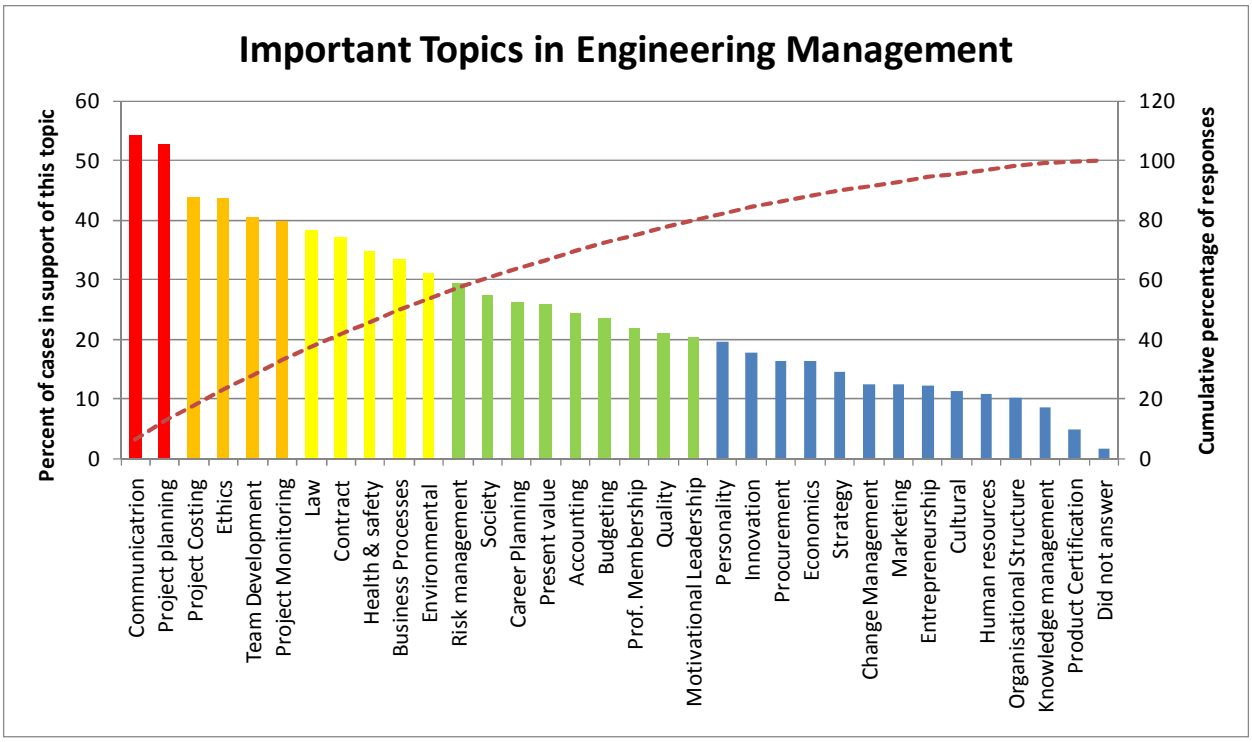

Figure 3: Support for various topics in engineering management. Engineers felt that the most important topics were communication and project planning.

The above results are for the profession as a whole. The analysis also went on to identify the specific topics relevant to electrical, mechanical and civil engineering disciplines separately. This showed that electrical had the greatest diversity of need, so that some of the topics that were of relatively minor importance to the profession as a whole were more important for the electrical disciplines, e.g. Accounting. By comparison civil Engineers reported primarily needing communication and project planning, in conjunction with just law and project monitoring. Mechanical Engineers reported intermediate complexity. The significance of this is that we now know which topics are important to the sub-disciplines, and this opens the possibility of customising the education and professional development.

The research also showed that the importance of various topics changed over a career: for example 'ethics' was always important but became even more important for Engineers in the mature stages of their careers. It was possible to identify gaps: places where starting Engineers rate a topic much lower than mature Engineers. The largest of these were in communication; business processes; contracts; ethics; law; health and safety; project planning; project costing; team development; and risk management. The implications are that starting engineers need to be better prepared in these areas, or concentrate on developing those skills during ongoing professional development.

What are the critical success factors that will guarantee to make me rich, you might ask? Well, we can't answer that directly, but we can say that Engineers with high job points (a proxy measure for remuneration) tended to identify certain topics as particularly important, and of those there were some which starting and middle-career Engineers tended to overlook. So these are where,

on average, it might be a good place to start developing some skills: they could be to your own personal competitive advantage in the future. Those skill-sets are communication, contracts, health & safety, project planning, project costing, risk management, and team development.

It's interesting to see that, whichever way you look at the data, communication and project planning always come up as most important. Many of us left school and selected engineering because we liked the science and technology. The reality of professional practice is that the technical skills we learn are simply necessary. Excellence requires going beyond the technology and being able to communicate with other people, and tackle problems with an intelligent and structured approach (as opposed to ad-hoc).

Engineering is about solving complex problems, which do not present entirely in the scientific and technical dimensions. Instead complex problems intersect with business and society, and have to be solved by teams of people rather than individuals. It's therefore not-surprising to find that professional practice involves a whole new skill-set in engineering management.

The research was conducted with IPENZ members, and had a sample size of approximately 2200 responses covering a variety of disciplines and practice areas. The full results with statistical analyses are documented in three papers, which have been submitted for publication elsewhere, and details are available on request from the first Author. The Authors acknowledge with gratitude the involvement of the Institution of Professional Engineers New Zealand (IPENZ) for provision of survey data, particularly Dr Andrew Cleland (CEO) and Brett Williams (Director - Learning and Assessment).